BRIDGE RATINGS

INTRODUCTION

Bridge rating and load posting analysis (hereafter denoted by one word, rating) is administered and performed by the Bridge Rating Section of the MnDOT Bridge Office. Bridge ratings may also be done by other qualified engineers.

Definition, Rating: The determination of the live load carrying capacity of a new or existing bridge using bridge plans, supplemented by information gathered from a field inspection.

Bridge Ratings are calculated in accordance with the AASHTO Manual for Condition Evaluation of Bridges (MCE). This manual refers the user to the AASHTO Standard Specifications for Highway Bridges for much of the needed information.

FORMS AND DOCUMENTATION

The rating forms can be found on the Bridge Office Web Site at Documents, Downloads, Forms, and Links, in the section titled Bridge Rating and Load Posting Report for [County and Local Agencies].

Fill in the blanks that are applicable to the bridge and the type of rating you are doing. A minimum of two pages are required to document a rating, but additional sheets may be attached if needed. The cover page of the completed rating must be signed by a registered professional engineer.

SUBMITTAL / FILING

The original copy of the rating should be retained in the files of the bridge owner.

For bridges owned by counties and local units, copies of the ratings should be submitted to MnDOT, and will be kept on file by the Bridge Management Unit.

Copies of ratings for Trunk Highway bridges are kept in the files of the Bridge Ratings Unit.

GENERAL

Bridges are rated at two different stress levels, Inventory level and Operating level. The Operating level is used for load posting and for overweight permit checks.

Ratings are calculated and reported in terms of HS - 20. Thus with the HS - 20 truck as the live load in the denominator of the rating equation (AASHTO MCE 9-1a), and if the resulting rating factor is 1.15, then the rating would be reported as HS - 23.

Use a phi factor of 0.91 for prestressed concrete flexure in load factor rating.

All bridges are rated except those that carry pedestrians, recreational traffic, or railroad trains.

Box culverts and other culverts with spans of 10 to 20 feet are rated, but not by a calculated value, They are assigned rating values based on their design load or a physical inspection.

MnDOT rates the bridges on the state system (Interstate, US, and Minnesota). Counties, cities, etc. each rate their own bridges.

Ratings are performed by the Load Factor Method whenever possible. The Allowable Stress Rating and the Load and Resistance Factor Rating methods will sometimes be accepted alternatives.

The use of computer programs is preferred for rating. BARS has been used since about 1973. It is no longer supported by the developer and is being phased out. Virtis is the new program which is replacing BARS.

Bridges entered in Virtis should be in the Girder System Definition whenever the bridge geometric requirements will fit within the limitations of Virtis.

When using the Girder Line Superstructure Definition, rate an interior beam under a vehicle traffic lane.

In almost all cases only the primary load carrying members of the superstructure are rated. Decks or piers may have to be investigated in unusual circumstances such as severe damage or deterioration. Unusually heavy permit loads may also require investigation of the deck and piers.

Temporary bridges are rated, the same as permanent bridges. Also, overweight permit restrictions are regulated in the same manner as permanent bridges.

LOADS

Dead loads are calculated according to AASHTO.

Low slump concrete wearing courses and latex modified wearing courses are considered to be fully composite with the base slab. This might change for an individual bridge if an inspection showed that the bond between them was failing.

The top 0.5 inch of the wearing course or slab is not considered to be effective for composite action or section properties.

Composite section when deck is poured in two steps. This is usually 7 inches base, then a 2 inch low slump wearing course.

DL1 Is defined as noncomposite dead load (stage 1) and DL2 as composite dead load (stage 2). DL1 includes the weight of the beam, diaphragms, and the initial slab pour . The remainder of the dead loads are then in DL2. MnDOT considers the effective composite deck supporting DL2 to be the initial slab pour. The effective composite deck supporting the live load (stage 3) is the full deck including the wearing course minus 0.5 inch. Most computer programs including BARS and Virtis will not accept these two different thicknesses of composite deck for stages 2 and 3. It is then necessary to use the final composite deck thickness as the one that also supports DL2.

Include a dead load for utilities of 2 psf of deck area in rural areas and 3 psf in cities and urban areas. Higher loads may be required if heavier utilities are shown on the plan or have been placed on the bridge.

Use a stool height of 1.5 inches for bridges designed after 1990 and 1 inch for before. Add as uniform dead load an additional weight to account for additional stool, residual camber, slope of the deck, and superelevation.

Distribution of DL2: Railings, sidewalks, utilities and medians may be divided uniformly among all beams if they are located symmetrically on the cross section. Otherwise a different distribution method should be used which is logically sound.

Distribute live loads according to AASHTO. Standard gage width is 6 feet. For overweight permits treat gage widths of up to 7 feet as 6 feet. For gage widths wider than this, an adjustment may be made.

If the design includes an allowance for future dead loads, such as wearing course, these should not be included when calculating ratings.

RATING NEW BRIDGES

New bridges are to be rated anytime after the plan is completed and up to two weeks before the bridge is opened to traffic. The results are then turned in to the Bridge Management Unit for entering in Pontis.

If any changes are made to the bridge during construction that would affect the rating, these changes should be reported to the Bridge Ratings Unit (or the person who did the original rating), and also be recorded on the as built plans, The bridge rating will then be recalculated.

RERATING EXISTING BRIDGES

A new bridge rating should be completed whenever a change occurs that would affect the rating. The most commonly encountered types of changes are:

- a modification that changes the dead load on the bridge (such as an overlay)
- damage or deterioration that alters the structural capacity of the bridge. (Scheduled inspections are usually the source of this information.)
- repairs or remodeling.
- A change in the AASHTO Rating Specification
- An upgrading of the rating software.
- A change in laws regulating truck weights

TIMBER BRIDGES

For decks, use all the provisions of AASHTO Fig. 3.7.7.4 with applicable footnotes. In other words, rate decks with individual axles of 16 k or 17 k or whatever the posting truck has.

Use wet condition for all rated timber members.

The repetitive use factor, C_r, can be used for plank decks, if they are covered by bituminous or perpendicular planks for load distribution. C_r may also be used for laminated decks providing the panels do not show any separation or loss if lamination.

If timber members are in a deteriorated condition, their reduced capacity may be accounted for by either reducing the allowable stress or the section modulus.

When the original plan cannot be found, and the original design stresses cannot be determined from any other source, the following may be used for f_b:

Timber planks	1.5 ksi
Timber beams	1.6 ksi
Transverse Glu-Laminated Decks *	1.5 ksi
Transverse Nail-Laminated Decks **	1.35 ksi
Longitudinal Glu-Laminated Decks ***	1.4 ksi
Longitudinal Nail-Laminated Decks ****	1.2 ksi
Glu-Laminated Beams	2.0 ksi

* Commonly used for decks on temporary bridges. Usual depth = 5 1/8 in.
** Seldom used
*** Used less often
**** Commonly used for county and local bridges.

Assumed species: Douglas Fir-Larch

For the other stress categories such as shear, bearing, etc, refer to the AASHTO tables on the line corresponding to the f_b given above.

These stresses are for the inventory level. Increase them by 33 % for the operating level.

PHYSICAL INSPECTION RATING (PIR)

This method of rating is to be used when there is no bridge plan available and/or the capacity cannot be calculated. Follow AASHTO MCE 7.4.1

The rating is determined by the engineer upon careful consideration of all available information, including bridge condition (corrosion, spalling, damage, distress, cracking, etc.), age, type of construction, redundancy, traffic count (ADT or ADTT), loading (historic to present), etc.

The numbers in the rating should (approximately) follow this ratio: (1.67 x Inventory Rating) = (Operating Rating) = (the posting weight in Tons for the single truck) = (0.625 x the posting weight in Tons for a combination truck).

When a bridge is rated by PIR, it should be posted, at no higher than 26 T, 40 T, 40 T, unless it has a history of satisfactory performance at higher loadings. If not posted, overweight permits should be restricted.

A PIR rating is documented with Form PIR and accompanied by the cover form, RC - TH or RC - CL

The inspection interval should be the normal time, based on bridge condition.

The rating interval should be after each inspection.

FORM PIR Revised Mar 06	MINNESOTA DEPARTMENT OF TRANSPORTATION PHYSICAL INSPECTION RATING (Per AASHTO 7.4.1 - Manual for Condition Evaluation of Bridges)

Bridge Description

Hwy. No. _____ over / under _____ Bridge No. _____

Year Built _____ Year Remodeled _____ Replaces Br. _____

Type _____ County _____ ADT _____

Problem leading to this physical inspection rating: _____

Describe bridge; Spans, lengths, widths, depths, deck, wearing course, etc. _____

Describe Bridge Condition: _____

Other Remarks: _____

Bridge Sketch

Form PW Apr 06	Posting Worksheet	

Bridge No	
Rated by	
Date	

Truck	Wgt, TON	Rating Factor	Location	Limit State	Notes/Comments
T M 3	24				
T M 3S2-40	40				
T M 3S3	40				
T M 3S3 V	40				
SU4	27				
SU5	31				
SU6	34.75				
SU7	38.75				
NRL	40				

FORM RD–CL Revised Feb. 2005	BRIDGE RATING DETAILS

Bridge Type _____ Bridge No. _____

Rating Method _____ Design Load: _____

Roadway Width _____ Inventory Rating: HS - _____

☐ Curved ☐ Tapered Operating Rating: HS - _____

Beam Spacing _____ Rated _____ Checked _____

Live Load Distribution Lane Width Date _____

Single _____ Multiple _____ Sheet _____ of _____

BEAM ELEVATION ②

Show Span Lengths and Structure / Beam Depths

Truck	Rating Factor	Location	Limit State ①	Notes / Comments
HS 20 Inventory				
HS 20 Operating				
Post, M 3				
Post, M 3S2				
Post, M 3-3				

① Choose from: service or ultimate; shear or moment.
② Elevation may be on back or another sheet if it won't fit here.

FORM RC–CL Revised Mar. 2005	Mn/DOT BRIDGE RATING AND LOAD POSTING REPORT FOR COUNTY AND LOCAL AGENCIES

Bridge Location and Description

Bridge No. _____

Hwy. No. _____ over / under _____

Year Built _____ Year Remodeled _____ Replaces Br. _____

Type _____ County _____ Ref. Pt. _____

Description _____

_____

Location _____

Data for Basis of Report (Check all that apply)

- ☐ Bridge Inventory File
- ☐ Previous Bridge Rating and Load Posting Report
- ☐ Bridge Plans
  - ☐ New ☐ Overlay
  - ☐ Repair/Reconstruction _____
  - ☐ Other Dead Load Modifications _____
- ☐ Bridge Inspection Report, by _____ ,date _____
  - ☐ Damaged Component _____
  - ☐ Deteriorated Component _____

Type of Analysis:

☐ Manual ☐ Computer* ☐ BARS ☐ Virtis, V._____ ☐ Other*

* _____

Method of Rating (Check appropriate box)

- ☐ Load Factor (LF)
- ☐ Allowable Stress (AS)
- ☐ Load & Resistance Factor (LRFR)
- ☐ Load Testing
- ☐ No Rating Computations Performed

Design Load _____

Design Method _____

Summary of Rating and Load Posting Analysis

Load Posting Limits Posting: ☐ Required ☐ Not Required			Bridge Rating	
Vehicle Type M3	Semi-Trailer Type M3S2	Truck-Full Trailer Type M3-3	Inventory Rating	Operating Rating
_____ Tons	_____ Tons	_____ Tons	HS _____	HS _____

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.

Signature: _____ Date: _____

Typed or Printed Name: _____ Reg. No. _____

VIRTIS GUIDELINES

Resources for Rating Information

Original plan ----- Repair plan ------ As built plan -----

Existing rating ----- Bridge Inventory data ----- Inspection reports

Bridge Description

BID	Assigned by Virtis
Bridge I D	Bridge number (usually 5 digits).
NBI Structure I D	Same as Bridge I D
Bridge Completely Defined	Check this box to indicate whether or not the bridge superstructure is completely defined in this Virtis file.
Name (Bridge) *	Enter the three digit bridge type. (See Bridge LRFD Design Manual, 2 – A.) If there is more than one type in the bridge, enter the type of the main (or lowest rated ?) span and add the suffix, m (for multiple).
Year built	Year of construction
Description	*[Select those that apply from this list, add others if needed.]* This Bridge was copied from it's twin, Br xxxxx Twin to Br xxxxx Number of spans. Other bridge types if multiple types in one bridge. Note if different ratings apply to each side of bridge or direction of traffic or if bridge has one way traffic. Flare or curve, note if present. Skew angle. Describe dead load distribution: Sidewalks, medians, rails, etc Describe in detail if for any reason the computer model deviates from the plan. Does / does not have end blocks.[For prestressed beam bridges] Replaces Bridge xxxx. Initials of person rating and date completed.
Location	City name, or (for example): Baudette, SE 23 mi.
Length	xxxx feet

Facility carried	Facility carried **over** the bridge. Use the highway abbreviation without periods. If the bridge carries one way traffic, add this as a suffix. Examples: I 94, I 35 SB, US 12, US 2 WB, MN 36, CSAH 44, CR 88. If no highway number exists, use the street name/number, etc.
Route number	Often the same as Facility carried. If a minor road crosses over a major highway, enter the major highway number. May be a second highway no.over/under. Omit Prefixes (I, US, MN, CSAH, etc.)
Feature intersected	Highway, river, or feature **under** the bridge.
Mile post	Blank at this time.
Units	English preferred
Recent ADTT	Blank at this time.
District	Select from pull-down menu
County	Select from pull-down menu
Owner	Select from pull-down menu
Maintainer	Select from pull-down menu, Usually same as owner.
Administrative Area *	Select from the pull down menu. (This is used for sorting into folders.)
NHS Indicator	Blank at this time.
Functional Class	Unknown

* This field is being used for an alternate purpose, as defined by the MnDOT Bridge Rating Section

General

Set tolerances, in Configuration Browser, System Defaults, Tolerance tab:

Units	Tolerance
ft.	0.01
in.	0.05
mi.	0.010

Use the girder system method whenever practical.

Let the system define effective widths even though the calculation is liberal.

Use the material strengths as given on plan. If there is no plan and no other source is available, select from the values given in the MCE based on the year of construction.

Under STRUCTURE DEFINITIONS, Load Case Description, the Composite Dead Load (DL2) needs to be separated into two (or more) items (lines). This is because LRFR will use different load factors for each of them:

D, DC includes: original wearing course, railings, median, sidewalk, etc

D, DW includes the future wearing course and utilities.

For new bridges use concrete deck strength of 4 ksi. (Class C)

When selecting concrete reinforcement, check box if epoxy coated.

Deck profile: Total thickness: Enter the depth of the initial deck pour. In the girder system method enter the actual wearing course. In the girder line method, the wearing course is calculated manually and entered as weight per foot in member loads. (The effective width and depth for composite action is entered elsewhere.)

The default setting for transverse distribution of dead load 2 is uniformly to all beams. This is the preferred method when the loading is symmetrical across the bridge width. When the load is not symmetrical, another distribution method may be chosen, or a dummy load may be added to make it symmetrical.

In a Virtis window where the engineer is asked to select a name for a parameter, select a name that is short and descriptive. Some examples are:

PARAMETER FULL NAME	Short name
Bridge Alternatives	Br Alt 1
Stress limits – concrete	PS Conc 7.5
Stirrups for prestressed bm	# 4 Inv U
Prestressed Properties – strands	Strd 0.5 in

Completion of Rating

Compare new bridge ratings calculated with Virtis to any old rating that may exist, and resolve any major discrepancies.

Fill out and sign forms for the new rating. The signature page is to be filled out and signed in ink.

Verify that the bridge rating can be run from the Bridge Explorer.

Prestressed Concrete

In stress limits, select the beam concrete strength. Round down to the nearest 100 psi in the agency library. Adjust the F'ci strength.

Set shear calculation limits to comply with AASHTO section 9.20.2: To change this go to the Member Alternative window. Click on the Engine tab and configure engine properties to BRASS LFD. Click on Properties then go to the Miscellaneous tab and at the bottom of screen are two options. Select the option "no limit on Mcr/Mmax". (The default setting is "limit Mcr/Mmax to 1.0".) (Note that if the shear has been turned off this choice will not be available.) Note that this may have to be set multiple times for each bridge.

> *Explanation: Concrete shear for PCBs is calculated from the lowest of Vci or Vcw, per AASHTO 9.20.2. In the calculation of Vci there is a term Mcr / Mmax. When the AASHTO code was first developed the ratio of this term computed to be less than 1 for the commonly used PCB shapes. In fact Dr Jay Puckett did some research and showed this term should be limited to 1. In BRASS with version 5.3 and before, this term was limited to 1 based on Puckett's research and not the code. With Virtis 5.3.1 we now have the option of allowing this ratio to go above 1.0 and MnDOT is electing to do that.*

If the rating is controlled by shear at the end of the beam, turn off the Virtis set tenth point checks. This is found at the member alternative, engine tab. Then add points of interest at h/2, 1/10, 2/10, 3/10, and 5/10.

If shear still controls the rating, also check and record the rating with shear turned off and record RF on the Bridge Rating form table in the notes column.

Concrete Slab Spans

Enter a strip of slab one unit wide.

Use a slab depth of the full depth minus 0.5 inch. (Thus considering the wearing course as fully composite with the base slab and of the same strength.)

The remaining 0.5 inch is entered in member loads as weight per foot.

Check the ignore shear box.

Steel Beams, Composite

The girder schedule is the preferred method to enter beam sizes.

Items not required to enter: welds, bolts, splices, rebar in the slab (unless specifically designed for this).

If the beam was designed for composite action in the negative moment region, rate it the same way and with the longitudinal slab rebars included.

The contraflexure points must be entered in as a percentage of span. You can get these from either the girder elevation plan sheet or the dead load moments in Virtis.

Follow AASHTO Guide Specification for Curved Steel Bridges, 2003, if beams have curvature.

Be careful to input correct stool height.

Verify diaphragms and stiffener locations on elevation view.

If diaphragms are straight on a skewed bridge make sure to account for two stiffeners and diaphragms close together.

BRASS calculates plastic capacity for simple spans. It does not if the girder is a hybrid.

Check to see that critical locations are not artificially low at counterflexure points. If so then adjust counterflexure points in engine tab so this won't control.

Use elastic rating for continuous steel rating. See equation 10-129c. This is controlled by ***not*** checking compact, located at -Member Alternatives- (member name)-engine-BRASS LFD-properties.

Virtis does not do the 10% redistribution per AASHTO 10.48.1.3

Do not let bearing stiffeners control the final rating.

Virtis 5.3.1 will rate floor beams and stringers.

Timber

Virtis does rate timber decks for moments. Use the provided MathCAD sheet to rate decks for shear. This might control the rating.

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Form 90 Revised: Apr 07	Culvert Rating Form	
Bridge Number:	Year Built:	Year Remodeled:
County:	Bridge Owner:	
Route:	Feature Crossed:	
Culvert Type:		
Structure Type Code:	Culvert Dimensions:	
No. of Barrels:	Barrel Length:	

Rating Guidelines

Material	Culvert Type	Structure Type Code	Inventory Load Rating	Operating Load Rating
Cast-in-place Concrete*	Box	113	HS 22.0	HS 33.0
	Type W Box (1930 era)	113	HS 16.0	HS 24.0
	Footing Supported Arch	112	HS 20.0	HS 30.0
Pre-cast Concrete*	Box	513	HS 24.0	HS 36.0
	Footing Supported Arch	512	HS 20.0	HS 30.0
	Round Pipe	514	HS 24.0	HS 36.0
	Pipe-Arch	515	HS 22.0	HS 33.0
***For Load Factor HS 25 Design Structures use:**			**HS 25.0**	**HS 42.0**
Aluminum	Box	913	HS 14.0	HS 21.0
Metal	Footing Supported Arch	312	HS 12.0	HS 18.0
	Round Pipe	314	HS 16.0	HS 24.0
	Pipe-Arch	315	HS 16.0	HS 24.0
	Elliptical	316	HS 16.0	HS 24.0
Timber	Box	713	HS 14.0	HS 21.0
Masonry	Footing Supported Arch	812	HS 18.0	HS 27.0

The above table may be used as a guideline to the culvert rating.

If the culvert condition code is 4 or less, rate by Physical Inspection Rating instead of this form.

Inventory Rating	

Operating Rating	

Rated by (please print) _____

Title _____ Date: _____